Toxicity of platinum nanoparticles to freshwater algae and crustaceans

Giron Delgado, Cristina; Sørensen, Sara Nørgaard; Engelbrekt, Christian; Baun, Anders

Publication date:
2013

Document Version
Publisher's PDF, also known as Version of record

DTU Environment
Department of Environmental Engineering

Technical University of Denmark

Toxicity of platinum nanoparticles to freshwater algae and crustaceans

Cristina Giron Delgado[1], Sara Nørgaard Sørensen[1], Christian Engelbrekt[2] and Anders Baun[1*]

[1] Department of Environmental Engineering, Technical University of Denmark
[2] Department of Chemistry, Technical University of Denmark
***abau@env.dtu.dk**

Introduction & Objectives

In recent years several nanoparticles types have been studied, however only few studies cover the toxic effects of platinum nanoparticles (PtNPs) to aquatic organisms. PtNPs and platinum nanostructures can improve the catalytic activity and they have been widely used in automobile catalytic converters for many years. Due to this extensive use, emission of PtNPs into the aquatic environment must be expected and the investigation of their ecotoxicity is therefore highly relevant and important.

Therefore, the aim of this study is to:

1) Evaluate of the acute toxicity of $PtCl_4$ and PtNPs towards *Pseudokirchneriella subcapitata* and *Daphnia magna* .

2) Investigate the uptake and depuration of PtNPs in *Daphnia magna*.

Materials & Methods

Tested material:

PtNPs	Starch coated PtNPs of nominal size 1.7±0.2 nm
$PtCl_4$	Dissolved platinum reference

Algal tests with green algae *P. subcapitata*:

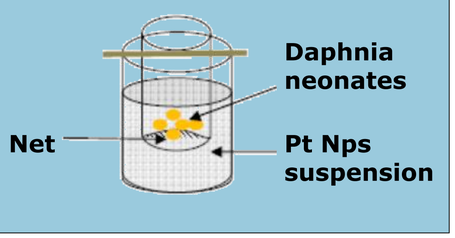
48h test	OECD 201 growth inhibition test
2h test	Newly developed 2h ^{14}C-assimilation inhibition test

Crustacean tests with *D. magna*:

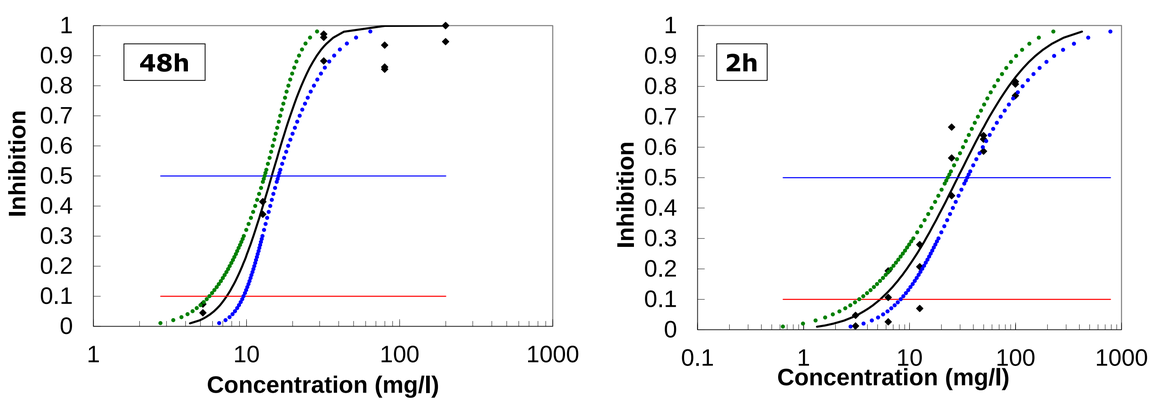
48h	OECD 202 mobility inhibition test
48h	Newly developed anti-sedimentation test:

Uptake and depuration test with *D. Magna*

Uptake	during 24h exposure to PtNPs
Depuration	during 24h in clean medium



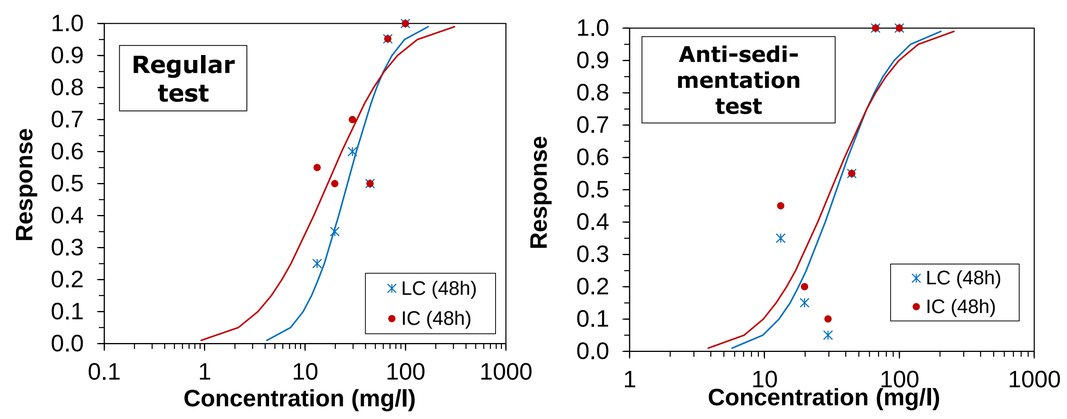
Results: Algal Toxicity



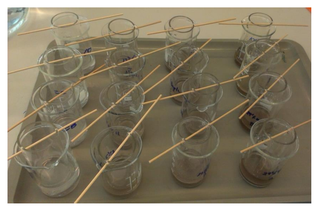
Short term test (2h) in comparison with 48h: try to minimize the aggregation, sedimentation and possible interactions of PtNPs.

	$PtCl_4$ (mg Pt/l)	PtNPs (mg Pt/l)
Algae 48h	EC_{50} = 1.3 $[1.1;1.5]_{95\%}$	EC_{50} = 14 $[13;16]_{95\%}$
Algae 2h	Toxicity not found	EC_{50} = 28 $[23;25]_{95\%}$

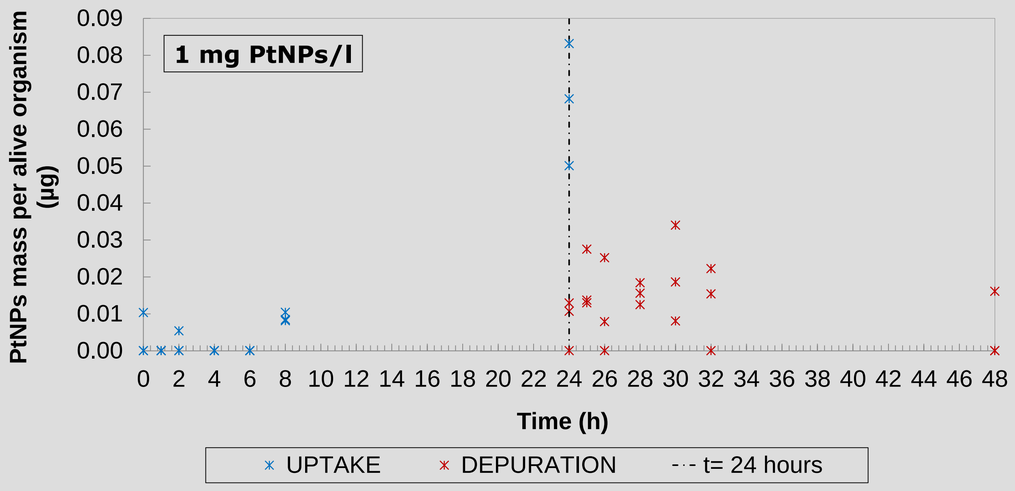
Results: Daphnia Toxicity



	$PtCl_4$ (mg Pt/l)	PtNPs (mg Pt/l)
Daphnia 48h (regular test)	IC_{50} = 1.7 $[1.4;2.3]_{95\%}$	IC_{50} = 17 LC_{50} = 26 $[21;32]_{95\%}$
Daphnia 48h (anti-sedimentation test)	Not performed	IC_{50} = 31 LC_{50} = 34



Results: Uptake / Depuration



Significant increase of PtNPs in Daphnia bodies from the 6th hour to complete the 24 hours of exposure. When the animals are transferred to clean medium, a fast depuration occur. PtNPs remain inside the organisms after 24 hours depuration in clean medium.

Conclusions

- **Algal toxicity tests**: Pt salt is more toxic than PtNPs. PtNPs are toxic within 2h and its toxicity is dependent on the time of exposure.

- **Daphnia toxicity tests:**
  - › In the regular test $IC_{50} > LC_{50}$: significant number of animals were alive but immobile.
  - › In the anti-sedimentation test $IC_{50} \approx LC_{50}$: immobilization due to particles settling is almost avoided. Reducing sedimentation, the number of died (immobile) animals are reduced too.

- **Algae vs. daphnia toxicity:** Almost similar toxicity, however algae is a bit more sensitive to both $PtCl_4$ and PtNPs.

- **Uptake / Depuration study:** Uptake of PtNPs in daphnia is initially slow, but increases after 6h exposure. A very fast depuration is found upon transfer to clean medium. Not all PtNPs are depurated in 24h.